

A Regional Waterway Management System for Balancing Recreational Boating and Resource Protection

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Abstract Florida's coasts have been transformed over the past three decades as population growth and unprecedented demand for individual shore access to bays and estuaries led to the creation of residential canal developments. Thousands of miles of channels and basins were dredged as a by-product of this urbanization process. The navigable waterways that resulted are now being stressed by increasing boat traffic and canal-side activities. Recognizing their common goal to preserve the recreational and ecological value of southwest Florida waterways, the Florida Department of Environmental Protection, the four-county West Coast Inland Navigation District, and the University of Florida Sea Grant College Program signed a Memorandum of Agreement. The signatories agreed to develop a science-based Regional Waterway Management System (RWMS), which is a new approach to waterway

planning and permitting based on carefully mapped channel depths, a census of actual boat populations, and the spatial extent of natural resources. The RWMS provides a comprehensive, regional overview of channel conditions and the geographic distribution and severity of existing impediments to safe navigation and resource protection. RWMS information and analyses result in regional-scale permitting to accommodate water-dependent uses while minimizing environmental impacts and reducing public expenditures. Compared with traditional approaches to waterway management, the science-based RWMS is relatively unbiased, objective, transparent, ecologically sound, and fiscally prudent.

Keywords Waterway management · Comprehensive waterway planning · Recreational boating · Regional permitting · Vessel transportation infrastructure · Channels · Navigation · Dredging

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Introduction

Coastal communities face a critical challenge: how to balance the use and protection of their waterway resources. Florida's coastal shoreline—in the United States, second only to Alaska's—is linked to thousands of miles of In-tracoastal Waterway (ICW), man-made canals, and natural estuarine and riverine systems that are surrounded by residential and commercial development. The state's coastal waters are popular recreational destinations for residents and visitors alike. Leeworthy (2001) cited Florida as the number one U.S. destination for marine recreation activity. Florida is also the number one fishing destination (USDOI 2006).

Boating is one of the most popular waterway activities, and it is big business in Florida. Murray (2005) estimated that Florida's marine industry and related sectors had an economic impact of \$18.4 billion and employed 220,000 people. Florida has the most registered boats in the U.S. (USCG 2008). In 2007, 1.027 million boats were registered in the state; 97% were used for recreation (FWC 2008). The Florida Fish and Wildlife Conservation Commission (FWC) estimates that an additional 350,000 vessels not registered in Florida were used on state waters in that same year (FWC 2008). In recent years, the growth of boat registrations has exceeded that of Florida's population. For example, population increased by about 15% between 2000 and 2006, while the number of registered recreational boats grew by 18% (BEBR 2007). By 2016, Florida's population is projected to increase by another 18% (BEBR 2007) and, if current trends hold, about 1.38 million boats will be registered in the state by 2016.

As Florida's once pristine bay, estuarine, and river systems are transformed into "urban seas," complicating factors arise, such as damage to fragile seagrass meadows from increased turbidity, pollution, and prop-dredging; vessel collisions with manatees, an endangered marine mammal; increased congestion and conflict between waterway users; and more frequent boating accidents and related fatalities. Sargent and others (1995) reported that the four contiguous coastal counties in southwest Florida that are the geographic focus of this article—Manatee, Sarasota, Charlotte, and Lee (Fig. 1)—ranked 4th, 5th, 9th, and 11th out of Florida's 35 coastal counties in percentage of seagrass acreage that had sustained prop scarring by boats. The proportion of total seagrass acreage scarred in each of these four counties ranged from 25 to 52%. A 2004 follow-up study conducted in two of the four counties indicated that seagrass scarring had increased by 38% in the 10 years since the 1995 study (Madley and others 2004). Collision with boats is the most common human related cause of manatee mortality in Florida, accounting for approximately 24% of all deaths since 1976 (USFWS 2001).

Environmental impacts to Florida's waterway resources are exacerbated by boaters' reliance on an informal network of channels that was never designed for vessel transportation. This is because many channels in Florida's nearshore coastal waters used by recreational boats are the unintended consequences of dredge-and-fill operations to create waterfront land for residential and commercial development (Antonini and others 2002). Over time, the incremental effect of these land-making operations was the creation of a de facto vessel transportation network comprising thousands of kilometers of manmade finger canals linked to natural bays, estuaries, and riverine systems. Each new residential canal development provided more boats

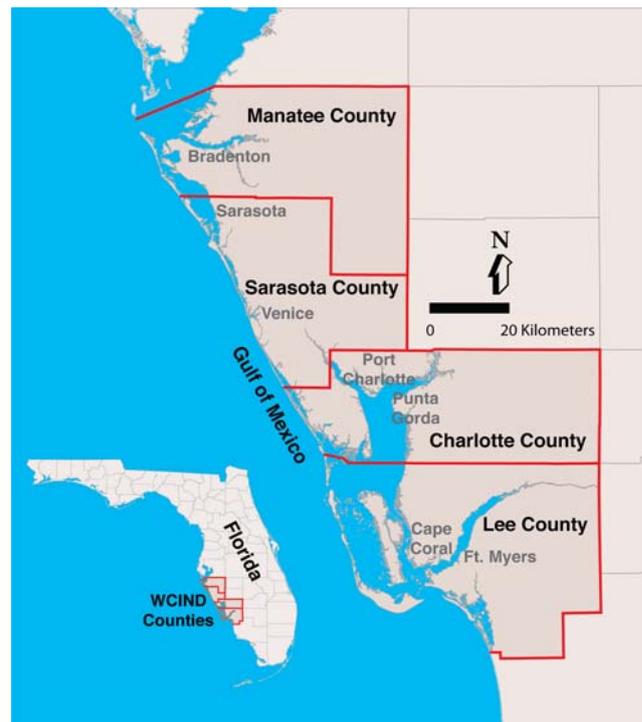


Fig. 1 Manatee, Sarasota, Charlotte, and Lee counties, the geographic focus of this article, are experiencing conflicting demands for environmental protection and recreational use of resources. Together, they compose Florida's West Coast Inland Navigation District (WCIND)

with direct access to local waterways (Fig. 2). This ad hoc transportation system continues to serve an ever-increasing number of boats, and it is showing signs of stress. Over 120,000 boats are registered in Manatee, Sarasota, Charlotte, and Lee counties and, given current trends, the approximately 2,500 km of channels in that region may need to accommodate about 160,000 recreational vessels by 2016. The situation is aggravated as residential development advances inland, increasing the number of boats trailered to coastal waterways.

This growth in waterway use challenges users, elected and appointed officials, resource managers, and planners to sustain and protect the environment without isolating people from nature. Can we continue to use waterways and preserve aquatic and marine environments as needed to maintain the economic and social vitality of coastal communities for generations to come? The problems to be addressed call for increased planning and management of waterways in ways that balance public use with resource protection. Florida's legislature recognized this need in 2005 when it passed House Bill 955 enacting Law of Florida, Chapter 2005-157, which mandates waterway use planning by local governments. This article describes a Regional Waterway Management System that addresses waterway use challenges in Florida.



Fig. 2 Redfish Point (1944, *left*, and 1999, *right*) in the city of Cape Coral, on the Caloosahatchee River, illustrates the sweeping transformation of southwest Florida's natural coastal features into a water-based transportation system

The Regional Waterway Management System

The Regional Waterway Management System (RWMS) is a GIS-based framework for achieving municipal, county, and state goals of facilitating safe navigation and reducing impacts on aquatic habitats (Antonini and Box 1996; Swett and Fann 2002). The RWMS begins with scientific data and results in the implementation of regional waterway management policy. It originated with a 1997 Memorandum of Agreement signed by the Florida Department of Environmental Protection (FDEP), the West Coast Inland Navigation District (WCIND), and Florida Sea Grant (FSG). In the Memorandum, the three signatories agreed upon shared principles that form the conceptual basis of the RWMS and guide the development of management policies. In particular, they acknowledged:

- The ecological and recreational value of southwest Florida waterways;
- A common goal to preserve the ecological and recreational value;
- The significant use of the waterways by recreational vessels that traverse sensitive bay habitats; and
- The need for a science-based management framework to address problems associated with the increasing use of the waterways.

Essential Partnerships and Capabilities

The Memorandum of Agreement is important not only for the principles it delineates, but more so for establishing a cooperative partnership between the signatories: three organizations whose capabilities and combined management, research, and regulatory functions are essential for successful implementation of the RWMS.

The West Coast Inland Navigation District is a special taxing district created in 1947 by the Florida Legislature to share, with the federal government, the cost of planning,

constructing, and maintaining a 245-km long Gulf Intra-coastal Waterway for commercial shipping (Parks and Pearce 2001; Sidman and others 2001; Antonini and others 1999). Commercial vessel traffic within District waterways has since declined significantly, while recreational boating has flourished. In response, the District's mission grew to include planning and implementing waterway projects that promote safe navigation and the enjoyment of ever-expanding water-based activities, such as boating, fishing, and beach recreation. Today, the District serves nearly 1.5 million citizens in Manatee, Sarasota, Charlotte, and Lee counties. Though only four (6%) of Florida's 67 counties are District members, together they account for approximately 8% of Florida's population and 12% of its registered boats (FWC 2008; BEBR 2007). In addition, an unknown but significant number of users of District waterways come from interior counties and other states and countries. The District's role in implementing the RWMS is to coordinate the activities of the Memorandum signatories with local governments and to provide project funding and oversight.

Florida Sea Grant is one of 30 university-based Sea Grant programs in coastal and Great Lakes states. The mission of this network, which is administered through the National Oceanic and Atmospheric Administration (NOAA), is to conduct research, education, and extension projects to foster science-based decisions about the use and conservation of coastal and marine resources. Florida Sea Grant and the West Coast Inland Navigation District conceived the RWMS, and FSG developed and implemented the methods to collect, code, store, analyze, and present relevant information for management and regulatory decisions. Sea Grant also helps facilitate the process that leads to state policy, permits, and projects implemented on the basis of RWMS methods and data.

The Florida Department of Environmental Protection is the lead state agency for environmental management and stewardship. The Department's role in the RWMS is to use

the data and analytical products in the development and adoption of regional permits. RWMS products can also be used by the Department, other regulatory agencies, local governments, and the public to guide the siting and permitting of new boating facilities, as well as the purchase and use of vessels appropriate for RWMS waterways.

The Memorandum also provides local governments and waterfront community organizations a mechanism to achieve regional waterway improvements within an ecosystem-wide, place-based management approach. The involvement of county governments is critical to successful implementation of the RWMS. For example, RWMS efforts in Lee County have benefited from the collaboration of its Marine Services Program. Lee County is unique among Florida's counties in that it created a governmental program to address all of its waterway management and planning needs. Other counties distribute these functions across multiple departments.

The Structure of the Regional Waterway Management System

A fundamental concept upon which the RWMS is based is the recognition that, in order to separate recreational boats from vulnerable aquatic resources and to improve navigational safety, a vessel transportation infrastructure needs to be delineated, institutionalized, and maintained. Florida House Bill 955 validated this concept by mandating amendment of the recreation and open space element of local comprehensive plans to indicate a comprehensive system of sites for recreation, including access to waterways.

An important step towards achieving the objective of a formalized vessel transportation infrastructure is a regional overview of channel conditions and the geographic distribution and severity of existing restrictions to navigation. To accomplish this step, RWMS efforts include the incorporation of existing spatial data into a GIS and field surveys to collect missing data (Fig. 3). Once collected, the data are analyzed within the GIS, and the resulting information is presented in formats that best inform the decision-making process. The signatories use this information to delineate and characterize the regional channel infrastructure. A subsequent step occurs when Memorandum signatories, in conjunction with county representatives, use RWMS information and analyses as the basis for management decisions and regulatory policies. Their deliberations and decisions are guided by the following intentions:

- Fit channel maintenance to the draft requirements of the local boat population.
- Minimize impacts on surrounding bay habitats.

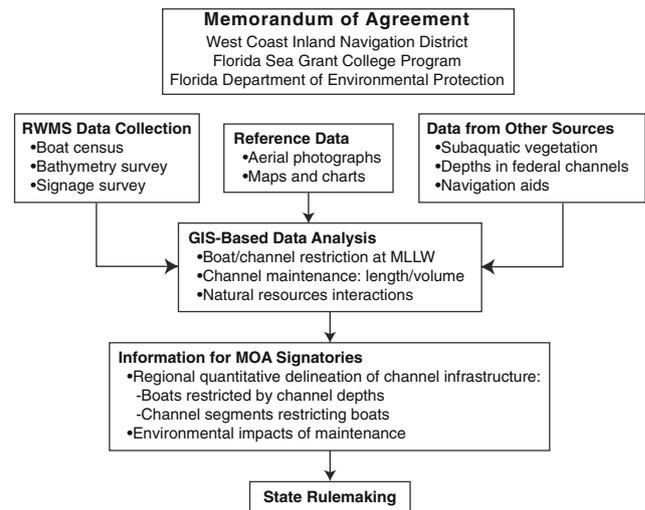


Fig. 3 The Regional Waterway Management System flows from scientific data to area-wide waterway management policy

- Prioritize and evaluate management alternatives on a regional basis.
- Develop maintenance standards for secondary/arterial waterways.

The remainder of this article describes each RWMS component in detail.

Data and Information Required to Implement the Regional Waterway Management System

The foundation of the RWMS is comprehensive, on-the-water surveys (inventories) of the locations and characteristics of: (1) boats, moorings, and related facilities, (2) boating-related signs, and (3) channel centerline depths. These field surveys are necessary because no other suitable data sources for vessel locations and waterway characteristics currently exist. The remaining spatial datasets required for the RWMS—including shoreline, mangrove, seagrass, and management boundaries, such as aquatic preserves—are from existing sources such as Florida's Water Management Districts and other state agencies. One-foot (0.30 m) resolution digital aerial imagery and/or 1-m resolution U.S. Geological Survey digital orthophoto quarter quadrangles (DOQQ) serve as the GIS base map.

The procedures that were used to conduct field surveys for coastal waterways in Manatee, Sarasota, and Lee counties are described below. (RWMS data collection efforts for Charlotte County are currently under way.) It is important to note that the particular equipment and field procedures used are not as important as the resulting data; other methods and equipment can meet the data requirements.

Boats and Moorings Survey

An on-the-water survey maps locations and records characteristics of boats and moorings on all salt-water accessible canals and waterways. Features are logged at every salt-water accessible residential, commercial, and governmental facility; information collected includes location, type, draft, length, age, make/model, and mooring type (Moorings are defined as boat locations that are either occupied or vacant). Vessel drafts are estimated to the nearest 0.5 foot (0.15 m). The survey is conducted during the peak boating season—December through April in southwest Florida—to capture the greatest presence of seasonal residents and transient vessels. It is recognized that the survey is a “snapshot” of the boat population at the time investigators visit each vessel location; this caveat is considered in the subsequent analyses using the data.

Signage Census

The signage census determines the location and characteristics of all boating-related signs within a project area. Characteristics logged for each sign include its location, type, message, status, and condition. The census is conducted before the channels are sounded, in order to create maps of sign locations and characteristics to guide the depth survey. Knowledge of the spatial distribution of signs also provides important insights into boating routes and boater behaviors.

The boats and moorings surveys and the signage censuses completed to date have used a Trimble Pro XR DGPS, U.S. Coast Guard beacon receiver, TSC1 data logger, and an Advantage range finder (Laser Atlanta Optics, Inc.) to determine the offset from the observer’s location to the position of surveyed features. The average horizontal positional accuracy was about 1 m.

Channel Depth Survey

The bathymetric survey records depths for channel centerlines and approaches to boating facilities. Before fieldwork, the boating channels to be surveyed are identified by interpreting 1:2,400-scale section aerials, by field reconnaissance, and from local knowledge of area boaters. In addition, during the survey a series of initial transects and zig-zags (Fig. 4) displayed on the onboard equipment ensure that the deepest waters are measured.

Depths collected are recorded to the nearest 30 mm using a Bathy-500MF multi-frequency, single-beam echo sounder (Ocean Data Equipment Corporation) and a Standard Horizon DS150 single beam echo sounder. The horizontal position of each sounding is recorded, to within a meter, using a Trimble DSM212H 12-channel

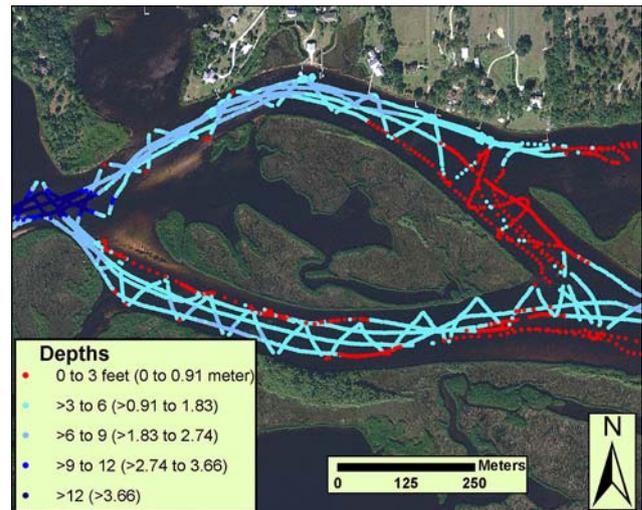


Fig. 4 Point soundings (in the upper Manatee River, Manatee County, Florida, in this example) are symbolized by depth category to help identify channels. The zig-zags are sounded first, in order to discover the deepest parts of the waterway. Measured depth points are later converted to line features for geographic information system analysis

Differential Global Positioning System (DGPS) receiver. A sounding pole is used to verify any suspect sounder readings and to check depths in shallow areas (<approximately 1 m). Depth soundings are corrected to mean lower low water (MLLW)—the nautical chart datum—using tide level recordings from ultrasonic fluid level sensors (Infinities USA, Inc.) mounted on stilling wells.

Field surveys completed to date in Lee, Manatee, and Sarasota counties have resulted in tide-corrected depths for 1,745 km of channels, and data—including position—for 45,485 boats associated with those channels, 80,262 moorings, and 10,841 signs directed to the attention of boaters on the water (Antonini and Box 1996; Antonini and others 2000; Fann and others 2002; Swett and others 2000a, b, 2001).

Characterizing the Regional Vessel Transportation Infrastructure

The boat drafts and channel depths mapped and characterized during RWMS field surveys are analyzed within ArcGIS (a commercial geographic information system produced by the Environmental Systems Research Institute) to identify: (a) for each channel segment, which boats may be restricted—and by how much—and (b) for each boat, which channel segments may present a problem of shallow water and the severity of the hindrance. The analysis delineates and quantifies, at 0.15 m vertical accuracy, levels of *boat accessibility to deep, open water*, and the location and extent of corresponding channel depth

restrictions. Deep, open water—defined as a function of vessel draft—begins at that location in the transit of a vessel, from its berth, beyond which the vessel is no longer restricted to a channel because of environmental or depth limitations. Boat accessibility refers to the difference between a boat's draft and the depth of the shallowest downstream channel segment that it must traverse to gain access to open water.

The ArcGIS-based restriction analysis requires two spatial data themes as input: channels and boats. The channel theme, which is created in ArcGIS using the tide-corrected survey point depths, is converted to a route system. A typical travel route includes channel segments within a canal system that lead to deep, open water. To begin the channel and boat restriction analysis, each boat feature is assigned to a particular travel route at a specific point of entry. The analysis routes each boat down its assigned travel route and compares its draft to the MLLW depth of each channel segment along the way. For each boat, (a) the controlling (shallowest) downstream depth, to the nearest 0.15 m and (b) the difference between boat draft and controlling depth are calculated. For each channel segment, (a) the draft, to the nearest 0.15 m, of the deepest vessel located upstream; (b) the number of boats located upstream that are restricted at MLLW by the segment; and (c) the segment's restriction level, which is defined as the difference between its MLLW depth and the maximum draft of vessels located upstream, are determined. For example, a channel segment with a depth of 2.5 feet (0.76 m) will restrict a boat of 3.5-foot (1.07 m) by 1.0 foot (0.30 m).

The results of the channel and boat restriction analysis are summarized at the level of *trafficheds*, boat source areas from which vessels exit via a common channel to

secondary access channels and, ultimately, to deep, open water. Secondary access channels are those that serve more than one traffiched. Trafficheds serve as units of segmentation that facilitate waterway management objectives; they allow for data generalization and reduction for GIS analysis and subsequent management and policy recommendations. Typically, trafficheds are residential canal systems, marinas, or natural creeks and rivers.

A typical traffiched, including the information that results from the channel and boat restriction analysis, is depicted in Fig. 5. Channel segments are represented as lines and boats as dots and the restriction levels of each are depicted. The levels represent worst-case scenarios, based on the deepest draft vessel upstream. There are four levels of restriction: (a) somewhat restricted (0.0–0.5 foot [0–0.15 m] interference at MLLW), (b) restricted (1.0–1.5 foot) (0.30–0.46 m), (c) severely restricted (2.0–2.5 feet) (0.61–0.76 m), and (d) blocked (3.0 feet [0.91 m] or greater). The Memorandum of Agreement signatories use the restriction analysis results to delineate and institutionalize the regional vessel transportation infrastructure.

Delineating and Institutionalizing the Regional Vessel Transportation Infrastructure

A GIS model/visualization of the regional waterway system is the basis for all discussions between the Memorandum of Agreement signatories and for any decisions and policies that they agree to implement. The GIS maps and characterizes the channel infrastructure and associated depths; channel markers and their characteristics; location and condition of surrounding aquatic resources; distribution and characteristics of the local

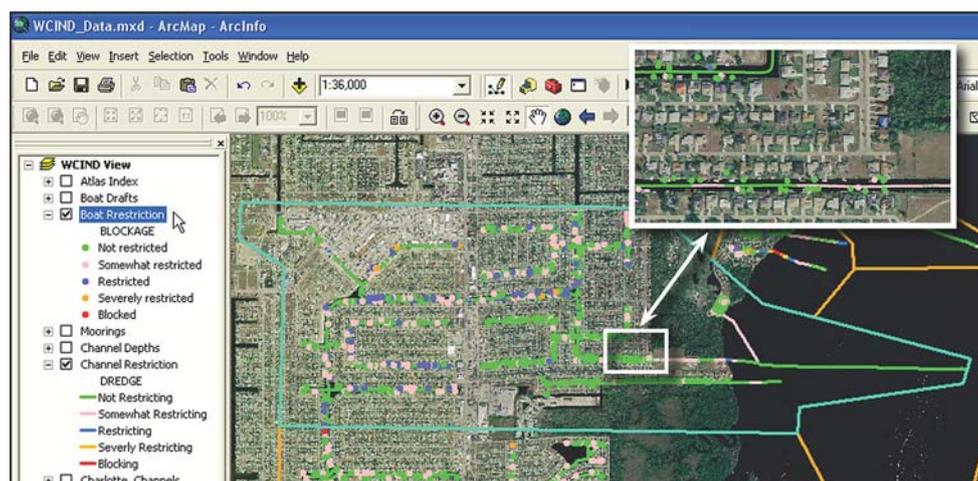


Fig. 5 Chantry Canal traffiched (highlighted), Cape Coral, Florida, is displayed in ArcGIS with boats and channels symbolized by restriction category. This presentation makes apparent which boats

may have access problems and which channel segments may be considered for maintenance

boating population; and relevant management boundaries, such as aquatic preserves. The GIS representation of the regional waterway system allows the signatories to query the mapped features and their characteristics, and to view important interrelationships between and among feature types.

The result is a regional navigation infrastructure defined by channel segments (lines) that compose a network of travel routes. An example of management decisions that can be implemented during this process is channel realignment to (a) take advantage of deeper waters, (b) avoid submerged aquatic resources, and/or (c) address safety concerns. Once the regional navigation infrastructure has been defined, the efficacy of existing signs—including those whose purpose is to regulate speed, guide navigation, protect resources, and warn of hazards—is evaluated considering route alignment, vessel traffic patterns, and boater behaviors, often resulting in the placement of new signs or relocation of existing ones.

Next, the signatories and county representatives use the RWMS data and analytical results to develop environmental resource noticed general permits (NGP), in accordance with Section 373.414(9) of the Florida Statutes (F.S.). These general permits are adopted as state rules within the Florida Administrative Code (F.A.C.), which is the official compilation of the rules and regulations of Florida's regulatory agencies. *NGPs can only be adopted for activities that have no significant individual or cumulative adverse impacts to the state's water resources.* The process to adopt an NGP includes drafting the rule; approval by the state agency head; publication in the *Florida Administrative Weekly*; opportunities for public comment, hearing, and objections; and filing the rule for adoption by the state in accordance with Section 120.54, F.S.

The NGPs authorize defined activities within *public* navigation channels and canals within trafficsheds and secondary channel systems identified using RWMS data, such as the Intracoastal Waterway and any other waterway determined by the WCIND Board to make a significant contribution to boat traffic in the four-county district. Examples of channels that serve a public purpose are those that lead to ramps, marinas, or other facilities accessible by boat and open to the public. The NGPs include limitations and general and specific conditions to prevent violations of state water quality standards and significant adverse impacts to water resources, such as seagrass beds and manatees.

Deliberations by the signatories led to adoption of Rule 62-341.490, F.A.C., "Noticed General Permits for Dredging by the West Coast Inland Navigation District (WCIND)," effective August 4, 2002, which authorized dredging of public navigation channels and canals in Manatee and Sarasota counties. The rule-making process

began with consideration of 674 km of public and private navigation channels and 15,825 boats, 24% of which were restricted at MLLW. The 51 trafficsheds selected for inclusion in the NGP contain 74% of the restricted vessels in the two counties. The Rule developed for Manatee and Sarasota counties serves as the model for the development of a Lee County Noticed General Permit, which incorporates additional management features and improvements to the rule-making process followed in Manatee and Sarasota counties. The next section describes the process undertaken in the development of the Lee County Rule.

Developing a Noticed General Permit: The Lee County Example

Analysis of navigation channels and salt-water accessible boats associated with 147 trafficsheds and 12 secondary channels in Lee County revealed that 126 km of channels (12% of the total) restrict 7,128 boats (25%) at MLLW. Considered for inclusion in the NGP were trafficsheds and secondary channel systems that (1) have restricting channel segments, (2) serve a public purpose, and (3) would not result in significant adverse impacts to water resources if improved.

Figure 6 shows information used to prioritize and allocate channel maintenance resources for one trafficshed (Chantry Canal), such as counts of all boats and restricted boats, displayed by draft and by severity of restriction, along with channel lengths and estimated dredge volumes for restricted segments. The approved trafficsheds and secondary channel systems are assigned a controlling depth that balances navigational access with resource protection. When dredging is appropriate, the prescribed depth and width depend on factors such as regulatory and historical precedents, potential environmental impacts, drafts of the boat population, and cost.

The Lee County NGP differs from that of Manatee and Sarasota counties because many trafficsheds and secondary channels in Lee County are (1) within state-designated *aquatic preserves* and (2) within waters that contain significant amounts of rooted aquatic macrophytes (seagrass) and other resources, such as corals, oysters, sponges, and macroalgae. Aquatic preserves are exceptional areas of submerged lands that are to be protected, preserved, enhanced, and managed by Florida's Board of Trustees of the Internal Improvement Trust Fund. The NGP excludes dredging within living communities of corals, sponge beds, oyster bars, and the macroalgae of the family *Caulerpaceae* and to avoid dredging of seagrass communities to the maximum extent practicable. Seagrass beds and individual specimens of the other resources that are encountered are to be relocated.

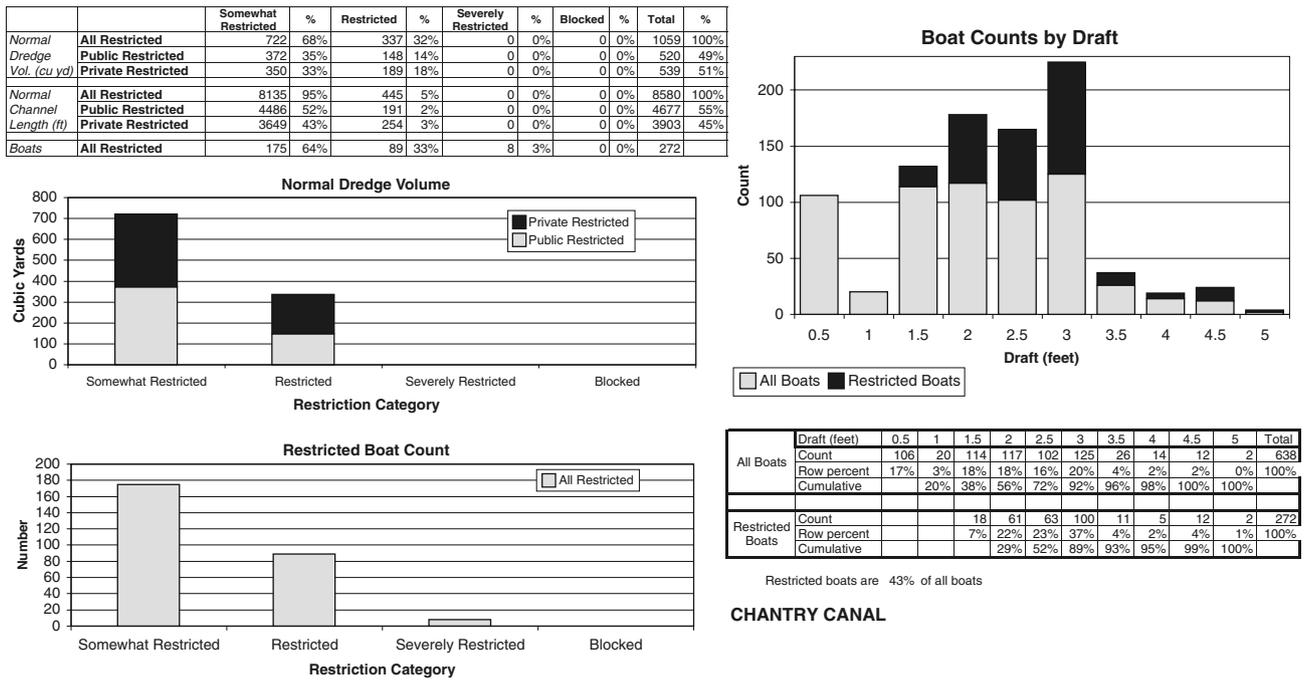


Fig. 6 Quantitative data from Regional Waterway Management System (RWMS) analyses enables prioritizing trafficheds and secondary channel systems to develop a Noticed General Permit

Nonetheless, some loss of seagrass is inevitable. The signatories to the Memorandum and Lee County representatives agreed that mitigation would take the form of “No Internal Combustion Motor Zone” (NICMZ) areas that would be demarcated by signs and located in areas of scarred seagrass to allow for their protection and restoration. NICMZ locations were chosen to provide the greatest probability of success, based on vessel traffic patterns, visibility to boaters, enforceability, severity and spatial distribution of seagrass damage, ease of marking and regulating the zone, and proximity to affected aquatic preserves. In addition, each NICMZ must be large enough and provide sufficient functional value to offset the anticipated resource impacts from dredging, based on the criteria in Chapter 62-345, F.A.C., the “Uniform Mitigation Assessment Method” rule.

The signatories are finalizing the draft language for the Lee County NGP, which is to be Rule 62-341.494, F.A.C., “Noticed General Permit for Maintenance of Public Navigation Channel and Canal Infrastructure by the West Coast Inland Navigation District within Lee County.” It addresses 36 priority trafficheds and 12 secondary channels in county waterways. When approved, it will provide for the maintenance of approximately 2% of Lee County’s navigational infrastructure over a 5-year period, to commence once the rule is adopted by the state of Florida. Approximately 56% of Lee County boats that are currently restricted at MLLW will no longer be restricted after implementation of the NGP (assuming residential property

owners complete the maintenance responsibilities for their private waterways). Furthermore, 97% of the restricted boats within the 36 NGP trafficheds will no longer be restricted. The next step is public hearings, after which the Lee County NGP will go through the remaining rulemaking process required by Chapter 120, F.S. This typically requires approximately six months, but is subject to rule challenges. Once adopted, the NGP will require information regarding the trafficheds, secondary access channels, and NICMZs to be disseminated via public informational materials, such as the *Lee County Boater’s Guide*. The next section summarizes the benefits provided by the Memorandum of Agreement, the Regional Waterway Management System, and the Noticed General Permit.

Conclusions

The Regional Waterway Management System offers unbiased information for rational, objective, and efficient allocation of waterway management resources over large areas (e.g., multiple counties). The Memorandum of Agreement provides the required state-approved framework to implement management decisions and regulatory policy, such as NGPs. Advantages include: (1) greater efficiency and effectiveness stemming from regional waterway maintenance priorities; (2) significant savings in taxpayer dollars and staff time; (3) better public policy through a comprehensive, environmentally based decision-

making process; and (4) state policy based on the “best available science.”

The RWMS provides the basis to improve public boating channels and routes from a series of ad hoc user “trails” to a defined boating transportation infrastructure. The information and analyses produced as part of the RWMS enable managers, planners, and regulators to evaluate and design waterway maintenance options in consideration of the mapped extent of sensitive habitats, such as seagrass beds. Resource managers and regulators traditionally have responded case-by-case to individuals, businesses, or neighborhoods seeking help to deal with water depth restrictions affecting isolated boat populations. A common solution has been to dredge an entire channel to a standard depth to free the deepest vessel present at all tide levels. The RWMS provides resources to identify the minimum dredging necessary to maintain public access for vessels that use a particular channel or waterway network. This typically involves “surgical” dredging—deepening only as needed the specific portions of a channel or waterway that are restricting navigation of the vessels actually using it—which minimizes expense, production and disposal of dredging by-products, and resource impacts.

Public waterways in certain high-priority Lee County trafficsheds illustrate the benefits of using RWMS data in management decision-making. Improving all public channels in each trafficshed to a uniform depth to accommodate the deepest boat present—an unlikely scenario today—would require dredging an estimated 138,000 m³. Using RWMS results, surgically dredging public channels and canals to free the same number of boats would entail removal of half that amount. In addition, the RWMS identifies boats that would still be restricted by shoals in “private” channels after public channel maintenance, a useful consideration in assigning management priorities and for identifying public/private partnership opportunities for waterway maintenance.

The NGP process—underpinned by the science-based RWMS—already benefits counties by savings in permitting and project design costs. A significant cost benefit of the NGP is minimizing that portion of public funds—often the majority for individual waterway maintenance projects—spent on obtaining regulatory permissions to commence waterway maintenance projects. The NGP spreads administrative, overhead costs across multiple maintenance projects throughout a region and for a longer period, thus substantially lowering overall costs, to the benefit of the public. Taxpayer savings to date in Manatee and Sarasota counties have exceeded \$2.5 million dollars (C. Listowski, personal communication, March 24, 2008). These cost savings are based on project estimates provided by county governments prior to implementing the RWMS and NGP, versus actual costs after implementation.

RWMS outputs provide local governments with: (a) documentation of existing depths; (b) channel maintenance dredging requirements that are established according to user draft specifications and minimization of resource impacts; (c) a process for regional-scale permitting to accommodate water-dependent uses and to minimize environmental impacts; (d) detailed knowledge of boat distributions and travel routes for management of boat traffic and placement of habitat restoration/protection projects; (e) information that facilitates the placement of signs to conform with boat density and traffic patterns; and (f) information that can be used to develop boater information and education products. The data and information on channels and vessels facilitate management decisions that are technically sound, environmentally acceptable, and economically justified.

Once the Charlotte County RWMS is completed in early 2009, a comprehensive dataset of boating infrastructure will exist for four contiguous counties in southwest Florida (Fig. 1). Development of the Charlotte County NGP that is expected to follow will complement the Lee, Manatee, and Sarasota county NGPs and, together with the RWMS data, they will define a regional transportation infrastructure. This will facilitate routing thousands of boats away from sensitive habitats, implementing habitat restoration and protection projects, and integrating management of hundreds of water bodies. Expectations are that this approach will save tens of millions of dollars when compared to traditional processes (C. Listowski, personal communication, March 25, 2008).

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